LIST OF PUBLICATIONS AND
SUMMARY OF THE MINERAL RESOURCES OF
WYOMING.

LIST OF PUBLICATIONS

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G. B. Morgan, State Geologist,
Cheyenne, Wyoming.

Mineral:

*Albany County: Beeler, 1906.
*Grand Encampment Copper District: Beeler, 1905.
*Laramie Peak Copper District: Beeler, 1904.
*Mines in 1907: Beeler, 1908.
*South Pass Gold District: Beeler, 1903.
South Pass Gold District: Beeler, 1904.
*Bull. 1, Mineral Resources: Jamison, 1911.
*Bull. 7, Atlantic City Gold District: Trumbull, 1914.
Press Bull. 10, Mineral Resources: Morgan, Oct. 1, 1920.

Miscellaneous:

*State Geologist's Report: Beeler, 1903.
*Bull. 6, Mining Laws: Trumbull, 1913.
*Bull. 9, Biennial Report; 1913-14: Trumbull, 1915.
*Bull. 16, Mining Laws: Trumbull, 1917.
*Bull. 17, Bibliography and Index: 1918.
Bull. 18, Mining Laws - State & Federal: Morgan, 1921.
Map, State Topographic, 1000-ft. contour: Price, $1.00.
Map, State Geologic: April 1, 1921.

Oil:

*Bull. 2, Fremont County (Lander Field): Jamison, 1911.
*Bull. 3-a, Douglas Oil Field: Jamison, 1912.
*Bull. 3-b, Muddy Creek Oil Field: Jamison, 1912.
*Bull. 4, Salt Creek Oil Field: Jamison, 1912.
*Bull. 5, Prospective Oil Fields: Trumbull, 1913.
*Bull. 8, Salt Creek Oil Field: Trumbull, 1914.
*Bull. 10, Basin-Greybull Oil & Gas Field: Hintze, 1915.
*Bull. 11, Pt. 1, Little Buffalo Basin Gas Field: Hintze.
Pt. 2, Grass Creek Oil & Gas Field:Hintze,1915.
*Bull. 12, Light Oil Fields: Trumbull, 1916.
*Bull. 13, Pilot Butte Oil Field: Ziegler, 1916.
Bull. 14, Byron Oil and Gas Field: Ziegler, 1917.
Bull. 15, Oregon Basin Gas Field: Ziegler, 1917.
*Sci. Ser., Bull. 1, Pt. 1, Petroleum in Granite.
Pt. 2, Effect of Structure upon Migration of Oil: Trumbull,1916.
*Map, Big Muddy-Douglas Oil Field: Trumbull, 1915.
Map, Rock Springs Uplift (Dry Lake Dome: Trumbull,1915.
*Press Bull. 2, Rawlins and Vicinity: Morgan
Press Bull. 4, Laramie Basin: Morgan, Oct. 24, 1919.
Press Bull. 7, Rock Creek Oil Field: Morgan, April 1, 1920.
Press Bull. 8, Osage-Newcastle Oil Field: Morgan, July 8,1920.
Press Bull. 9, Dry Piney-LaBarge Oil Field: Morgan, Aug. 1920.

* Out of print.

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PRESS BULLETIN NUMBER 10.

October 1, 1920.

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G. B. Morgan
State Geologist
Cheyenne, Wyoming.

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SUMMARY OF THE MINERAL RESOURCES OF WYOMING.

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CONTENTS.

PSRS. BULLETIN NUMBER 16.

October 1, 1920.

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G. A. Morgan
State Geologist
(Reporting in charge).

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SUMMARY OF THE MINERAL RESOURCES OF TENNESSEE.

CONTENTS.

SUMMARY OF THE MINERAL RESOURCES OF WYOMING.

The list of the minerals, both metallic and non-metallic, that are found within the boundaries of Wyoming, reads like a text book or a glossary of the known minerals. Few realize the extent and value of our deposits and the great number of minerals of economic value that are found in the State. In fact a great many of them have been very little prospected, much less developed, and practically nothing is known in regard to them except their occurrence. A survey of the lesser known minerals in this State would be of great value and would probably lead to much economic development. Inquiries covering a wide range of minerals are received almost daily and the writers invariably request information as to the location, quality, quantity and immediate availability of the mineral deposits in which they are interested. Much of this information is not to be had at the present time.

The mineral wealth of Wyoming is colossal and incalculable and in some respects intangible. Many of the common minerals that are considered worthless to-day may become valuable and bring great wealth and prosperity to the State in the future. The purpose of this article is to show the commercial importance and wonderful future of our mineral deposits.

COAL.

Coal is mined on a commercial scale in eight counties of the State; namely, Lincoln, Carbon, Uinta, SWeetwater, Sheridan, Weston, Hot Springs, and Fremont. Six other counties, Big Horn, Converse, Crook, Johnson, Park and Campbell, also contain many local, or wagon, mines of small production. Workable beds of coal are also found in Washakie, Natrona, Niobrara and Albany counties. The above lists include all of the counties in the State except one. The production of coal in Wyoming for 1918 was 9,300,000 tons; for 1919 it was 7,145,000 tons, a decrease due to labor shortage. The total value of the coal produced in 1919 exceeded $15,000,000.00. In the last five years approximately 40,000,000 tons of coal were mined in Wyoming, having a total value of about $80,000,000.

The total workable coal resources of the State may be set out as follows:

Green River Basin (Southwestern Wyoming).

Semi-Bituminous	22,600,000	short tons.
Bituminous	174,138,000,000	" "
Sub-Bituminous	491,500,000,000	" "
Total	665,660,600,000	" "

Big Horn and Wind River Basins (Northwestern Wyoming).

Bituminous	608,800,000	short tons.
Sub-Bituminous	3,467,700,000	" "
Total	4,076,500,000	short tons.

Central and Northeastern Wyoming.

Mainly Sub-Bituminous	408,883,000,000	short tons.
Grand total	1,078,620,100,000	short tons.

The list of the minerals, with statistics, can be made, of course, only from the Government's standpoint. Each line is a text book in a geology of the Union Alaska. The prices the errors and value of the deposits and the production is merely of economic value that are found in the State. In fact, some of them have been very little prospected, much less exploited, and individually a study is made in so much so that except their economic. A review of the lines which are available in this state would be of real value and would greatly add to such economic development. Industry seeking a wide range of material are received almost daily and the writer incessantly request information as to the location, quality, quantity and immediate availability of the mineral deposits in which they are interested. Such is this information is not to be had at the present time.

The mineral wealth of Alaska is unknown, is unknown and in some respects intangible. Many of the common minerals that are undisclosed worthless to-day become valuable and bring great wealth and prosperity to the State in the future. The purpose of this article is to show the commercial importance and economical nature of the mineral deposits.

Coal.

Coal is found on a commercial scale in eight counties of the State, namely, Bristol, Cordova, Kenai, Kodiak, Southeastern, Western, Yukon, Yukon-Kuskokwim, and Yukon. Six other counties, Big Lake, Converse, Cross, Johnson, Lake and Copper, also contain only lignite, or weak, altered or small productions. Workable beds of coal are also found in Seldovia, Matanuska and Alaska counties. The above list includes all of the counties in the State except one. The production of coal in Alaska for 1918 was 9,300,000 tons; for 1919 it was 7,140,000 tons, a decrease due to labor shortage. The total value of the coal produced in 1918 exceeded $12,000,000.00. In the last five years approximately 40,000,000 tons of coal were mined in Alaska, having a total value of about $80,000,000.

The total workable coal reserves of the State may be set forth as follows:

Green River Basin (Southwestern Alaska):

Semi-bituminous	32,000,000 short tons
Bituminous	174,150,000 " "
Sub-Bituminous	471,500,000 " "
Total	677,650,000 " "

Big Horn and Cook River Basins (Southeastern Alaska):

Bituminous	800,000,000 short tons
Sub-Bituminous	1,567,000,000 " "
Total	2,370,000,000 short tons

Central and Northwestern Alaska.

Only Sub-Bituminous	100,000,000 short tons
Grand total	1,000,000,000 short tons

cents per ton is $107,862,010,000.00. It is estimated that approximately 19,000,000 acres of land in Wyoming are coal-bearing.

The heat value of Wyoming coal averages fairly high. The British thermal units range from 9,500 in the lignites and sub-bituminous coals to 13,500 in the bituminous coals. The Newcastle bituminous coking coal and the coals from southwestern Wyoming show the highest values.

Wyoming coal deposits have been described in the following publications of the United States Geological Survey:

Field	County	Bulletin Number
Bald Mountain District	Sheridan	G. F. 141
Barber Field	Johnson	Bull. 531
Big Horn Basin	-------	Bull. 225, 285, 341, 381
		P. P. 53.
Black Hills	------	Bull. 260, 499.
Buffalo Field	Johnson	Bull. 381.
Cloud Peak District	------	G. F. 142
----------	Campbell	Bull. 471
----------	Carbon	Bull. 316
----------	Converse	Bull. 471, 541.
----------	Fremont	Bull. 471, 541.
Glenrock Field	Converse	Bull. 341
Great Divide Basin	Sweetwater	Bull. 341.
----------	Hot Springs	Bull. 541
----------	Johnson	Bull. 471, 531
Lander Field	Fremont	Bull. 316.
Laramie Basin	------	Bull. 316.
----------	Lincoln	Bull. 543.
Little Powder River Field	Campbell	Bull. 471.
Little Snake River Field	Carbon & Sweetwater	Bull. 341.
Lost Spring	Converse	Bull. 471
----------	Natrona	Bull. 471, 541.
Newcastle District	Weston	G. F. 107
Powder River Field	Campbell, Sheridan and Johnson	Bull. 341, 381.
Rock Springs	Sweetwater	Bull. 341, 381.
Southwestern Wyoming	-------	P. P. 56.
Sundance District	Crook	G. F. 127.
Sussex Field	Johnson	Bull. 471.
----------	Uinta	Bull. 285, 316.
Wind River Region	Fremont & Natrona	Bull. 471.

PETROLEUM.

The second great mineral asset of the State is probably petroleum. Wyoming oils are of two kinds, the light colored green and brown oils of high Baumé gravity and paraffine base, and the heavy black oils containing an asphaltum base. By far the greatest production ~~in~~ and values are in the light oils. Generally speaking, the light oils are

found in formations of the Cretaceous system and the black oil comes from much older rocks principally in the Carboniferous (Permian and Pennsylvanian).

The table following gives the production of petroleum by counties in 1918 and 1919:

County	1918	1919.
Big Horn	45,260 bbls.	54,031.725 bbls.
Carbon	------	506,294.725 "
Converse	3,082,026 "	3,267,302.225 "
Crook	------	54.34 "
Fremont	110,183 "	227,[illegible] "
Hot Springs	2,951,455 "	2,151,867.135 "
Natrona	5,336,927 "	6,018,806.36 "
Niobrara	------	498,016.695 "
Park	1,066,836 "	773,893.56 "
Sweetwater	------	279,465.395 "
Uinta (and Crook)	3,600 "	2,261.38 "
Weston	------	117,04 "
	12,596,287 bbls.	13,580,000.000 bbls.

For the first six months in 1920 the production of petroleum amounted to 7,950,000 barrels. It is estimated that the total production for 1920 will be more than 16,000,000 barrels.

The average price being paid for Wyoming oils to-day is $2.85 per barrel. Wyoming crude oil sales for this year will exceed $45,000,000.00

It is impossible to estimate the oil resources of Wyoming. There are 17 fields in the State where oil is being produced for the market. There are 17 other fields wherein oil has been struck but not marketed as yet. There are also scores of prospective fields or wildcat structures, some of which will probably be found to contain oil. More than one half of the oil production in the State is from the Salt Creek field. This is a wonderful oil reservoir. It has been producing about 10 years and production is still increasing strongly. It is roughly estimated that the Wyoming fields contain oil reserves amounting to about 400,000,000 barrels. The discovery of new fields will naturally increase this figure. The total production up to 1920 from Wyoming fields approximates 50,000,000 barrels, which is about 12½% of the estimated remaining available supply.

NATURAL GAS.

One of the largest and most promising of the undeveloped resources of the State is natural gas. Very little use has so far been made of the immense gas pools scattered throughout the central and western portions of the State . The annual consumption of gas from the oil and gas fields amounts to about 10 billion cubic feet, of which about 7 billion cubic feet are produced in the Byron and Hidden Dome dry gas fields, the balance being obtained from the various oil fields. The combined oil and gas fields of the State are capable of producing <u>one billion cubic feet per day</u> .

The following table shows the estimated daily capacity of the principal gas fields, assuming the normal use of the gas as being from 15 % to 25% of the open flow of the wells.

found in [illegible] of the Gatesburg region and the black oil crude from some other rocks principally in the Gorumlivoka (Permian) and Tengkylvsk[illegible].

The table following gives the production of petroleum by counties in 1918 and 1919:

County.	1918.	1919.
[illegible]	40,000 bbls.	[illegible] bbls.
[illegible]	------	[illegible]
[illegible]	3,020,020 "	[illegible]
[illegible]	------	[illegible]
[illegible]	[illegible] "	[illegible]
[illegible]	[illegible] "	[illegible]
[illegible]	[illegible] "	[illegible]
[illegible]	------	[illegible]
[illegible]	1,[illegible] "	[illegible]
[illegible]	------	[illegible]
[illegible]	[illegible] "	[illegible]
[illegible]	------	[illegible]
Total	12,300,[illegible] bbls.	[illegible] bbls.

For the first six months in 1920 the production of petroleum amounted to 7,920,000 barrels. It is estimated that the total production for 1920 will be more than 16,000,000 barrels.

The average price being paid for Gorumlivoka oil today is $2.25 per barrel. Thus the oil sales for this year will exceed [illegible].

It is [illegible] to realize the oil resources of [illegible]. There are 17 fields in the Grand State oil is being produced for the market, [illegible] other fields contain oil but are not worked as yet. There are [illegible] prospective fields in different stages, [illegible] of which probably [illegible] contain oil. [illegible] the oil production in the State is from the Gatesburg field. [illegible] a [illegible] oil reservoir. It has been producing about 10 years and production is still increasing at [illegible]. It is roughly estimated that the Gatesburg field contains oil reserves amounting to about [illegible] barrels. The discovery of new fields will naturally increase this figure. The total production in 1920 from Gatesburg fields approximates 5[illegible],000,000 barrels, which is about 1/[illegible] of the estimated remaining available supply.

NATURAL GAS.

One of the largest and most promising of the undeveloped resources of the State is natural gas. Very little use has as far been made of the immense gas fields scattered throughout the central and western portions of the State. The annual consumption of gas from the oil and [illegible] amounts to about 10 billion cubic feet, of which about 7 billion [illegible] are consumed in the Byron and Ulsden fields and the rest, the [illegible] being obtained from the various oil fields. The consumption of oil and gas fields of the State are capable of producing one billion cubic feet per day.

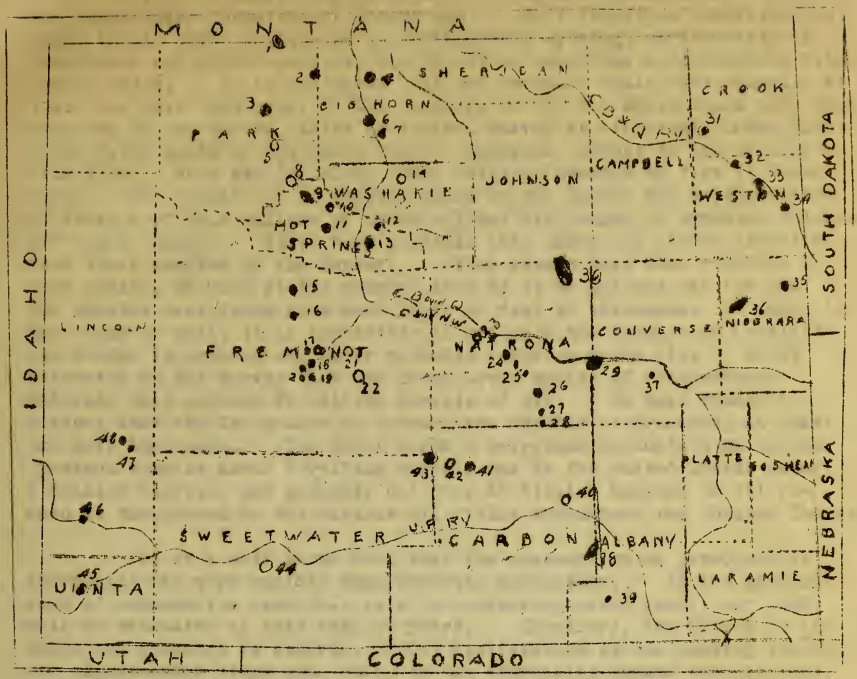
The following table shows the estimated daily consumption of the [illegible] at the fields, assuming the normal use of the gas as used from [illegible] of the wells.

Field	County	Normal Daily Capacity in millions of Cubic Feet.
Byron	Big Horn	50
Oregon Basin	Park	100
Little Buffalo Basin	Park & Hot Springs	125
Hidden Dome	Big Horn & Washakie	50
Golden Eagle	Hot Springs	30
Big Sand Draw	Fremont	45
Alkali Butte	Fremont	40
Rock Springs	Sweetwater	25
Powder River Station, Pine Mountain, Poison Spider, Iron Creek	Natrona	80
Mahoney	Carbon	60
Allen Lake, Medicine Bow	Carbon	45
Lance Creek	Niobrara	50
Total		700

In practically all of the producing oil fields casing-head gas is used for power and domestic purposes, and in the Grass Creek, Salt Creek, Elk Basin and Byron fields the gas is first passed through absorption or compression plants for the extraction of casing-head gasoline which amounts to about 10,000,000 gallons per year. The largest industrial use of gas is for the extraction of carbon black. The Byron field furnishes about 10,000,000 cubic feet per day to the carbon plant located at Cowley. Another carbon plant is located near Thermopolis, utilizing gas from the Golden Eagle field. The capacity of this plant is 2,000,000 cubic feet per day. The oil refinery at Greybull is using about 5,000,000 cubic feet per day, from the Hidden Dome and Byron fields. The city of Casper is now preparing to take gas for domestic and industrial use from the Poison Spider, Oil Mountain, and Iron Creek fields. The main pipe lines have been practically completed and distributing lines are now being laid. Of the available gas resources in Wyoming only about 3 per cent is being utilized at the present time. The average market price for natural gas at the wells is about 4 cents per thousand cubic feet.

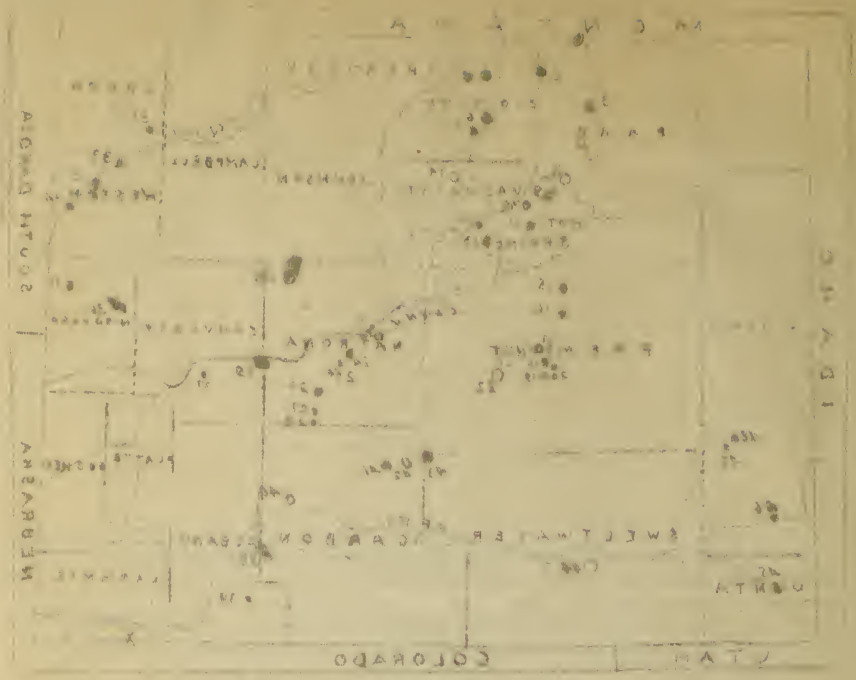
The gas resources invite wise and economic development and industrial use. They should appeal to such industries as glass, brick, tile, and cement manufacturing, especially since raw materials for such industries are to be found in many places in the State. Burning natural gas for carbon black may not be wasteful if carried on in fields where the gas is not available for other industries and domestic purposes.

The natural gas-gasoline industry depends to a great extent on the use of the gas for fuel or carbon black after treatment, inasmuch as it would be an unwarranted waste of gas to allow it to escape into the air from the gasoline plant. Owing to the high price of gasoline, great development and progress may be expected from now on in the production of natural gas-gasoline in Wyoming. Practically all of the gas in Wyoming contains a workable percentage of gasoline and some of it is exceptionally rich. Gasoline extraction from dry gas must go hand in hand with industrial development.



WYOMING OIL AND GAS FIELDS.
L.O. - light oil. B. O. - black oil. G. - gas.

1. Elk Basin, L. O.
2. Byron, L.O. & G.
3. Cody, L.O.
4. Crystal Creek, B.O.
5. Oregon Basin, G.
6. Greybull, L.O.
7. Torchlight, L.O.
8. Little Buffalo Basin, G.
9. Grass Creek, L.O. & B.O.
10. Golden Eagle, G.
11. Hamilton, B.O.
12. Kirby Creek, L.O.
13. Warm Springs, B.O.
14. Hidden Dome, G.
15. Maverick Springs, B.O.
16. Pilot Butte, L.O.
17. Plunkett, L.O.
18. Hudson, B.O.
19. Dallas, B.O.
20. Lander, B.O.
21. Alkali Butte, G.
22. Big Sand Draw, G.
23. Powder River Station, G.
24. Oil Mountain, G. & B.O.
25. Poison Spider & Iron Creek, G. & B.O.
26. Bates Hole, B. O.
27. Spindletop, B.O.
28. Bolton Creek, B.O.
29. Big Muddy, L.O.
30. Salt Creek, L.O.
31. Moorcroft, L.O.
32. Upton-Thornton, L.O.
33. Osage, L.O.
34. Newcastle, L.O.
35. Mule Creek, L.O.
36. Lance Creek, L.O. & G.
37. Douglas, L.O.
38. Rock Creek, L.O.
39. Big Hollow, B.O.
40 Medicine Bow, G.
41. Ferris, L.O.
42. Mahoney, G.
43. Lost Soldier, L.O.
44. Rock Springs, G.
45. Spring Valley, L.O.
46. Fossil, L.O.
47. LaBarge, L.O.
48. Dry Piney, L.O.



WYOMING OIL AND GAS FIELDS.
L.O. - light oil, H. O. - black oil, G. - gas.

1. Elk Basin, L. O.
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6. Greybull, L.O.
7. Torchlight, L.O.
8. Little Buffalo Basin, G.
9. Grass Creek, L.O. & H.O.
10. Golden Eagle, G.
11. Hamilton, H.O.
12. Airy Creek, L.O.
13. Lake Springs, H.O.
14. Elmore Dome, G.
15. Lovulick Springs, H.O.
16. Pilot Butte, L.O.
17. Plunkett, L.O.
18. Dutton, H.O.
19. Lillis, L.O.
20. Lander, H.O.
21. Little Butte, G.
22. Big Horn Dome, G.
23. Powder River Station, G.
24. Cottonwood, G. & H.O.
25. Poison Spider & Iron Creek, G. & H.O.
26. Bates Hole, H. O.
27. Spindletop, H.O.
28. Bolton Creek, H.O.
29. Big Muddy, L.O.
30. Salt Creek, L.O.
31. Moorcroft, L.O.
32. Upton-Thornton, L.O.
33. Osage, L.O.
34. Newcastle, L.O.
35. Dale Creek, L.O.
36. Lance Creek, L.O. & G.
37. Douglas, L.O.
38. Hook Creek, L.O.
39. Big Hollow, H.O.
40. Medicine Bow, G.
41. Ferris, L.O.
42. Saddle, L.
43. West Sublette, L.O.
44. Hook Springs, G.
45. Spring Valley, L.O.
46. Rosell, L.O.
47. Lusbrae, L.O.
48. Dry Piney, L.O.

The oil shale beds of Wyoming, Utah, and Colorado are found in the Green River formation of Eocene Age. This formation underlies vast areas in all three States and in southwestern Wyoming, particularly in Sweetwater and Uinta counties, the formation underlies approximately 3,500 square miles. It is estimated that the workable shale beds underlie at least one half that area. The outcrops of the oil shale seams have been examined by the United States Geological Survey at different places along Green River south of the Union Pacific Railroad almost to the Wyoming-Utah line. Beds sampled along these outcrops average 4½ feet in thickness. The results of 40 samples taken by the Survey and analyzed show an average of 15.8 gallons of crude oil and six pounds of ammonium sulphate per ton of shale. It is very possible that there are richer deposits than those sampled by the Survey. Other assays have been received in this office, showing yields ranging from 23 to 40 gallons per ton and the samples were taken from beds 15 to 60 feet in thickness. Owing to the lack of data, it is impossible to estimate the tonnage of available oil shales in Wyoming and their probable yield in crude oil. It is estimated by the Survey that the Green River shales of northwestern Colorado will produce 20 billion barrels of oil. We have reason to believe that similar shales in Wyoming are capable of producing at least one half that much. The total world's petroleum production up to the present time is about 7 billion barrels and in the United States about 5 billion barrels, and probably not over 6½ billion barrels of oil remain in the ground in the various oil fields throughout the United States.

It is a well known fact that the consumption of petroleum is increasing far more rapidly than domestic production. At the present rate of consumption (and this rate is increasing every year), our pools will be exhausted in less than 20 years. Therefore, the future of the shale oil industry is assured. Oil distillation is now passing through the experimental stage and, owing to the increasing demand for gasoline, lubricants and fuel oil, it will be a matter of only a very short time until oil shale plants will be operating in Colorado, Utah, and Wyoming.

Shale oil extraction is simply a mining and metallurgical proposition and is a matter of figuring plant and operating costs against the market price of oil and by-products, including gas which is used as a fuel in the retorts. There is not the element of risk in this industry as in prospecting for oil in unproved fields. Given a practicable and workable plant for destructive distillation, one is able to calculate with extreme accuracy the costs of mining and treatment added to the original cost of the plant and the amount of oil and by-products that can be extracted from a known deposit of shale, the contents of which have been carefully sampled and tested. It is also a simple matter to calculate the available tonnage of workable shale in a given area, especially if a diamond core drill is used to sample the underlying beds. Thus, it seems possible to forecast unusually well just what to expect in such ventures.

Although we do not believe that shale oil production will completely take the place of our dwindling petroleum supplies, yet it is not inconceivable that within ten years our shale fields will contain many extraction plants with millions of dollars invested and employing thousands of workmen.

The oil shale beds of Wyoming, Utah, and Colorado all belong to the upper Green River formation of Eocene age. This formation underlies vast areas in all three states and in southwestern Wyoming, particularly in Sweetwater and Uinta counties, the formation underlies approximately 5,000 square miles. It is estimated that the workable shale beds underlie at least one half this area. The outcrops of the oil shale zones have been examined by the United States Geological Survey at different places along Green River south of the Union Pacific Railroad almost to the Colorado-Utah line. Beds sampled along these outcrops average 14 feet in thickness. The results of 59 samples taken by the Survey are reported that show an average of 15.8 gallons of crude oil and six pounds of ammonium sulphate per ton of shale. It is very possible that there are richer deposits than those sampled by the Survey. Other assays have been reported on this field, showing yields ranging from 25 to 40 gallons per ton and the samples were taken from beds 15 to 50 feet in thickness. Owing to the lack of data, it is impossible to estimate the tonnage of available oil shales in Wyoming and their probable yield in crude oil. It is estimated by the Survey that the Green River shales of northwestern Colorado will produce 20 billion barrels of oil. We have reason to believe that similar shales in Wyoming are capable of producing at least one half that much. The total world's petroleum production up to the present time is about 7 billion barrels and in the United States about 4 billion barrels, and probably not over 6½ billion barrels of oil remain in the ground in the various oil fields throughout the United States.

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Although we do not believe that shale oil production will completely take the place of our dwindling petroleum supplies, yet it is not inconceivable that within ten years our shale fields will contain many extraction plants with millions of dollars invested and employing thousands of workmen.

All of the iron production in the State and most of the copper comes from the Sunrise mines in Platte County, operated by the Colorado Fuel and Iron Company. The ore is shipped to Colorado to be smelted.

Iron occurs as hematite in the metamorphic rocks of the Whalen Group. The principal workable deposit is found in the limestones and schists, being developed mainly along and not far from the contact between them. The Sunrise-Hartville mineralization begins about one and one half miles south of Sunrise and extends about four miles in a northeasterly direction to a point about a mile south of Frederick. There are also other deposits in this region which have not yet become of economic importance.

The copper occurs associated with the iron ores and also as replacement deposits in the massive gray limestones of the Guernsey formation. In the iron deposit, the copper occurs as chalcopyrite, chalcocite, and the carbonates and is found in pockets, whereas the iron is found in elongated lenses. It is reported that prospecting by the diamond drill has opened up a large remaining supply of iron ore in the Sunrise mines. The shipments for 1919 were 446,446 tons of hematite and 806.4 tons of copper ore.

Other copper mines in the State are operating with small production. There are several properties near Encampment, Wyoming, in Carbon County, and near Holmes and Centennial in Albany County, that are being re-opened and developed with the prospect of making commercial mines, and much activity is promised in the near future in other districts as well. The recent discovery of an important deposit of native copper near Tie Siding, Albany County, has brought renewed interest to the possibilities in copper mining in that district. The prospects or mines in the Silver Crown district west of Cheyenne are also drawing attention. Considerable high grade ore was shipped from some of these properties in the past, which was largely taken from shallow workings. Deep development will probably open up larger beds of lower grade ores. Prospecting for copper and associated minerals is still going on in the North Laramie Mountains in Albany and Converse counties, in Copper Mountain south of Thermopolis, and the Kirwin and Sunlight districts southwest of Meeteetse.

During the years 1913-1918, inclusive, the smelter reports showed 5,402,004 pounds of fine copper produced from Wyoming ores. The production for 1918 was 852,777 pounds of copper, valued at $210,636; for 1919 it was 124,816 pounds.

Iron and copper, as well as other precious metals of Wyoming, have recently come in for much attention and mention should be made of some of the undeveloped regions.

An immense deposit of titaniferous iron ore, called Iron Mountain, is located eight miles west of Iron Mountain station on the Colorado and Southern Railroad, in eastern Albany County. This deposit has been known for many years and some surface ore has been shipped. On account of its titanium content it is very refractory and no process has yet been devised to treat it commercially. However, it is fairly good ore, containing about 50% iron. There is no doubt that eventually some metallurgical process will be found that will render this deposit of great economic importance. Good iron deposits are also known to exist in the Seminoe Mountains at the foot of Bradley's Peak about 40

miles northeast of Rawlins. The ore is reported to be fairly high grade and to contain very little impurities, such as phosphorous and sulphur. The available ore is estimated at 1,500,000,000 tons. The lack of transportation is probably the only obstacle in the way of the development of this deposit. It is reported that some prospecting and re-locating have recently been done in the Seminoe region by one of the large oil companies operating in this State.

Another large deposit of iron ore is located near Atlantic City and still other deposits are reported in the Wind River Mountains west of Lander. The old Paint mine about two miles north of Rawlins must also be mentioned. This mine was operated for a number of years and the ore shipped to Salt Lake City for the manufacture of paint. It is a high grade hematite and occurs in the Cambrian quartzite.

An important deposit of chrome iron ore is found in Deer Creek Canyon in Converse County about 15 miles south of Glenrock. The ore contains 35% chromic oxide and 17% ferrous oxide. It occurs in a serpentine formation and the ore bed is about 600 feet long with a maximum width of 100 feet. Some development work has been done on this deposit in recent years and some ore has been shipped. At the head of Dutton Creek, Albany County, another deposit of chrome iron ore in mica schist has been reported.

PRECIOUS METALS

Gold and Silver.

Gold and silver, associated with other minerals, occur near Holmes, Centennial, and Jelm Mountain, Albany County; in the Bear Lodge and Black Buttes of Crook County; at Atlantic City and South Pass and in the Owl Creek and Wind River Mountains of Fremont County; near Hecla, Laramie County; and at Horse Creek near Merna, Lincoln County. A recent strike of gold and silver in the form of sylvanite has also been made in the Big Horn Mountains northeast of Basin. The Atlantic City and South Pass districts produced large amounts of gold in the early days. Recent gold production in Wyoming is very small and most of it comes from the copper ores of the Hartville, Sunrise and Medicine Bow districts. Much placer mining for gold was formerly carried on in the Laramie, Big Horn, Bear Lodge and Wind River Mountains and on the Shoshone, Clark's Fork, Green, and Snake rivers. No production is reported at this time.

The principal silver production also comes from the copper ores in the same manner as the gold. Deposits containing silver, associated with other minerals, are found in the Black Hills district, Crook County, in the Laramie Peak region and in the Wind River and Bear Lodge Mountains.

PLATINUM AND ALLIED MINERALS.

Platinum and palladium are found in the covellite ores of the old Rambler mine near Holmes, Albany County. This mine is being re-opened by a new company and important development may be expected.

URANIUM (RADIUM)

A deposit of carnotite (uranium) ore was accidentally discovered in an old silver prospect adjacent to the town of Lusk, Niobrara

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County. This ore has strong radio-active properties and is being shipped to Denver for reduction and extraction of radium-uranium salts. The amount produced in 1919 was 71.86 tons valued at $362.31 per ton. The ore occurs in pockets and lenses in a quartzite sandstone and is stained black, yellow and green. The discovery of this high grade material in a region that was prospected for gold, silver, and copper in the early days should stimulate renewed prospecting for the rare minerals that were formerly unknown, especially in the region between Hartville and Lusk and in the Rawhide Buttes, for there are a number of places where the metamorphic rocks come to the surface with possibilities of mineralization in the overlying sedimentaries.

LEAD, ZINC, TIN, AND COBALT.

Lead is found near Laramie Peak and Jelm Mountain, Albany County; at Ferris, Carbon County; at Black Buttes, Crook County; at Kirwin and in the Sunshine Basin and in the upper Shoshone region, Park County. No production is reported at the present time.

Zinc occurs in the iron ores of the Hartville district.

Stream tin ore, cassiterite, is found in the Nigger Hill district, Crook County, near the South Dakota line. No production.

Cobalt is reported in the gold and copper ores in the Medicine Bow Mountains near Holmes and with the copper ores of the Silver Crown district at Hecla.

ASBESTOS.

Asbestos, chiefly of the chrysotile variety, is found in the Casper and Laramie Mountains, Natrona and Converse counties; in the Seminoe and Medicine Bow Mountains, Carbon and Albany counties; in the Big Horn Mountains, Sheridan County; in the Black Hills, Crook County; and in the Wind River Range, Fremont County.

The principal deposits are in the Casper Mountains eight miles south and 20 miles southeast of Casper and in the Wind River Mountains near Atlantic City. In the Casper Range it occurs in veins principally in serpentine, but sometimes in granite and schist. Considerable development work has been done in this district and several mills have been erected to treat the low grade, short-fiber material which comprises most of the deposits. Some manufactured products have also been made from this low grade material. The deposit in Fremont County near Atlantic has yielded a small production of spinning fiber, but has not been operated commercially. Good commercial opportunities exist in the development of asbestos properties in Wyoming, which should be thoroughly investigated by technical men of experience who are also familiar with the trade conditions and the requirements of the asbestos industry.

ASPHALT (GILSONITE)

A deposit of asphalt has been found near Lander, or about four miles northeast of Fort Washakie, in wells drilled for oil at a depth of about 1,500 feet. It also occurs in Big Horn County on the western slope of the Big Horn Mountains, more particularly in Sections 28, 29, 32, and 33, T. 52 N., R. 89 W. No production is reported.

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BENTONITE.

Bentonite, sometimes called medicinal or paper clay, is found in the lower Benton formation of Cretaceous Age and occurs in almost every portion of the State, especially in the Big Horn and Laramie Basins. The following counties have available beds of bentonite: Albany, Big Horn, Converse, Crook, Fremont, Hot Springs, Johnson, Natrona, Park, Sheridan, and Weston.

Bentonite is a light colored, plastic clay, having a highly absorbent character and is found in beds ranging from a few inches to five or more feet in thickness. The outcrops are noticeable for their white, powdery appearance, contrasting with the otherwise black shales of the Benton formation. When freshly uncovered, it appears as a bedded joint clay and is easily mined. It is used as a medicinal clay (antiphlogistine), in making paper, and as an adulterant in the manufacture of drugs, soap and many other articles. Present output is largely confined to a deposit near Newcastle. Deposits near Rock Creek, Wyoming, formerly produced considerable amounts. The Newcastle production amounts to 25 cars per year and the price quoted quoted on this material is $7.00 per ton f. o, b. the cars at Clay Spur Spur, Wyoming.

CLAY (BRICK AND FIRE)

Brick clay may be found in abundance throughout the State. Common and pressed brick have been made in the following places from Wyoming clays: Laramie, Albany County; Basin, Big Horn County; Cody, Park County; Worland, Washakie County; Encampment, Carbon County; Douglas, Converse County; Gillette, Campbell County; Lander, Fremont County; Thermopolis, Hot Springs County; Casper, Natrona County; Wheatland, Platte County; Sheridan, Sheridan County; and Green River, Sweetwater County.

Fire clay is also found in a great number of places where the Cretaceous, Jurassic and Triassic formations are exposed. Many of these deposits are suitable for the manufacture of fire brick, tiling and terra cotta. A plant is being constructed at Lovell to make drainage tiling for use in draining bogged areas in the Big Horn Basin. Natural gas from the Byron field will be used for fuel.

In 1916, Wyoming produced 7,932,000 brick valued at $86,716.00. In 1917, the production was 10,699,000 brick valued at $103,140.00. The production for 1918 and 1919 has not yet been reported.

CEMENT MATERIALS.

Limestone and shale suitable for the manufacture of Portland cement are found in a large number of places, notably in northeastern Wyoming, the Big Horn Basin, the Laramie Basin, and southeastern Wyoming. The Minnekahta limestone outcropping near Newcastle and a bed of calcareous shale found in the Graneros formation of the same locality are both good raw materials for manufacturing cement. The Morrison and the Graneros formations of this district also contain good shale materials. In southeastern Wyoming along the eastern edge of the Laramie Range there are a number of deposits containing good cement materials. Near Iron Mountain the Niobrara and Minnekahta limestones and the Graneros and Pierre shales outcrop and the same formations are

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also found in the Laramie Basin to the west. The mountains surrounding the Big Horn Basin contain innumerable exposures of limestone in the Embar and Madison formations and shales in the Benton and Morrison formations, as likewise do the eastern slope of the Wind River Mountains in Fremont County and also the mountains of Uinta and Lincoln counties.

An ideal location for cement plants in Wyoming would be where the materials are found in connection with a supply of natural gas available for fuel. Such conditions probably exist at Casper, Greybull, Lovell and Cody. The natural gas may be obtained at these places from the Poison Spider, Hidden Dome, Byron, and Oregon Basin fields and limestones and shales are found in the Casper Mountains, in the canyons of the Big Horn River between Greybull and Lovell and south and west of Cody.

EPSOMITE.

Epsom salt, or magnesium sulphate, is found in soda lakes in Laramie, Carbon and Natrona counties.

Brooklyn Lake near Wilcox Station, Albany County, is reported to contain a large area of natural Epsom salt, and there are also other smaller lakes in this locality containing epsomite. Another important deposit of Epsom salt, associated with soda and potassium salts, is at Poison Lake, 18 miles from Douglas, Converse County. A reduction plant has been erected at this site; and commercial production recently begun. Good prices are being paid for this product.

FULLER'S EARTH.

Fuller's Earth is known to occur in the Chadron formation which is the basal member of the White River Group. This formation is found in a great number of places in eastern Wyoming, especially in Converse, Niobrara, Platte, Goshen, and Laramie counties. Although no Fuller's Earth operations have been reported, there is a possibility of discovering workable deposits near shipping points which will bear investigation. The average price paid in 1918 for eastern Fuller's Earth was $13.79 per ton.

Fuller's Earth is a clay which has the property of clarifying lard, petroleum, and cottonseed oils and is used largely in oil refineries and in packing houses. A chemical analysis is not sufficient to determine the quality of Fuller's Earth, but it must be tested by experimenting with oils.

GLASS SAND.

Glass sand has been produced in a quarry three miles east of Laramie from a soft sandstone of the Casper formation. It is found in abundance in nearly every county of the State. A glass factory is being built at Lovell to utilize a deposit near by, together with the Byron gas as fuel.

There is no question but that the glass industry has a future in Wyoming, especially in view of our vast reserves of natural gas which is the only fuel that can be used with success in glass manufacturing, on account of its cheapness, quantity, and ease of control. Thus, glass making in the United States is practically dependent on natural gas. The Cretaceous and Carboniferous series in Wyoming contain many beds of pure sandstone and limestone not a great distance from our principal gas fields.

GRANITE AND OTHER BUILDING STONES.

Granite is the core rock of most of our mountain ranges. The Laramie Range contains good quarrying granite as do most of the mountain systems of Wyoming. The Sherman Hill gravel, or disintegrated granite, covers a large area in the Laramie Mountains between Cheyenne and Laramie. The Union Pacific Railroad has quarried millions of tons of this material for use as road ballast and thereby has made its lines superior to nearly all other roads in road-bed construction. It is also very fine material for highway construction.

Building sandstone is also found in every portion of the State. Almost every town can avail itself of some sandstone deposit either for building purposes or for rough masonry. One of the principal quarries is at Rawlins, Carbon County, from which large quantities of sandstone have been shipped. Most of the important buildings of southern Wyoming, including the Capitol, are built of this stone. Limestone for building use is also quarried near Laramie, Albany County; near Rawlins, Carbon County; at Horse Creek, Laramie County; near Hartville, Platte County; Sheridan, Sheridan County; and Green River, Sweetwater County. Flux limestone is produced near Rawlins and Guernsey. Limestone for sugar beet refining is quarried at Granite Canyon, Laramie County; near Laramie, Albany County; and near Greybull, Big Horn County.

Marbles are also prevalent in many parts of the State. They are found in the rocks flanking most of the mountain ranges. Important deposits occur in the Hartville district in Platte and Goshen counties; at Plumbago Canyon; and near Douglas, Converse County.

GRAPHITE.

Amorphous graphite, or plumbago, is found in Fremont County near Miner's Delight, in the Haystack Hills near Ironton, in Goshen and Platte counties, and in Albany County about 27 miles northeast of Laramie. The latter locality is called Plumbago Canyon because of the number of graphite deposits therein. Some development work has been done on these prospects in the early days, The material is mostly low grade and mixed with impurities. Of the deposits in the Haystack Hills near Ironton and Frederick the most promising are located in Section 1, T. 27 N., R. 65 W., and Sections 14, 15, 22, 24, 25, 26, 27, 34, 35, and 36, T. 28 N., R. 65 W. In this area the graphite occurs in schist in the immediate vicinity of granite and pegmatite. Low grade ore is found in comparatively large veins. The Miner's Delight is reported to be extensive and high grade. No production is reported.

GYPSUM (GYPSITE).

Gypsum, calcium sulphate, is one of the most common minerals in Wyoming and is found in practically every county in the State. It occurs abundantly in the Chugwater, or Spearfish, formation ("Red Beds") and to some extent in the Embar or Park City formation. The "Red Beds" contain very large deposits ranging from a few inches to 60 feet in thickness. Some large deposits of the crystalline variety are found in the northeastern part of the State.

Gypsite is gypsum earth resulting from the disintegration and redeposition of the rock gypsum. The manufacture of plaster of Paris from rock gypsum and cement plaster from gypsite has been carried on extensively for a long time at Laramie and Red Buttes, Albany County. Plaster mills are being operated in the Big Horn Basin at Basin and Kane, Wyoming, and gypsum building blocks are also being made at Basin for use in that country where the climate is exceptionally dry.

The Wyoming production of gypsum for 1918 was 41,877 tons of raw material from which was manufactured 29,813 tons of plaster, valued at $195,143.00.

MANGANESE.

Manganese deposits have been discovered in the Laramie Peak region and near Marshall, Albany County, and in Big Horn, Crook, Fremont, Sweetwater and Uinta counties. An extensive deposit is located in the Bear Lodge Mountains, Crook County, about 10 miles north of Sundance. The ore is reported to contain 57½% of manganese dioxide. Some development work has been done on manganese deposits in this State, but no production is reported. It is used as an alloy in the steel industry. High grade ore is worth about $25.00 per ton.

MICA.

Muscovite mica is found in the Haystack Hills near Ironton and Frederick, Goshen County. It occurs in pegmatite dikes cutting pre-Cambrian schists. The principal deposits are in Sections 25, 26, 27, 34, 35, and 36, T. 28 N., R. 65 W., and in Sections 1, 2, and 3, T. 27 N., R. 65 W. Considerable development has been done on some of these prospects and some high grade sheet mica has been shipped. Probably high local transportation and freight rates are all that prevent commercial operations in this district. Important deposits of mica are found near Encampment, Carbon County, and in the Medicine Bow Mountains, Albany County, some of which have commercial possibilities. Veins of mica have also been discovered in the Casper Mountains, Converse and Albany counties; in the Wind River Mountains, Fremont County; and in the Black Hills, Crook County.

MINERAL WATERS.

Mineral waters, both hot and cold, are very numerous in many parts of the State. Most of them are said to contain valuable curative properties. These waters apparently have their origin in the beds of the Triassic and Permian series and contain lime, magnesia and soda as sulphates and chlorides, which salts are probably derived from these formations. The temperatures of the warm springs range from 90 to 140 degrees. The better known springs are located at Saratoga, Thermopolis, Cody, Fort Washakie, and Granite Canyon. In

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addition, mention should be made of the wonderful hot springs and geysers of Yellowstone Park, northwestern Wyoming. In 1918 41,335 gallons of mineral water were sold from Wyoming springs, valued at $5,513.00.

PHOSPHATE ROCK.

Phosphate deposits are found in Lincoln, Hot Springs, and Fremont counties, and cover an area which aggregates approximately 1,500 square miles of territory. The Government has reserved 998,592 acres of phosphate lands in western Wyoming, contiguous to Idaho and in the Wind River and the Owl Creek Mountains and has classified 25,076 acres in the Shoshone Indian Reservation, making a total of 1,182,816 acres. This land is open to development under the act of February 25th, 1920. The phosphate beds occur principally in the Embar or Park City formation of Carboniferous Age. They range from a few feet to 10 feet in thickness. The following is quoted from Mineral Resources, 1918, published by the United States Geological Survey:

> "The richest deposit reported in northwestern Wyoming is in the canyon of Snake River, 3 miles below the mouth of Fall River. Here, besides the main bed, 9 feet thick, a random sample from which yielded 68.5 per cent of tricalcium phosphate, there are several beds from 2 to 12 feet thick, carrying from 20 to 60 per cent of tricalcium phosphate. In southwestern Wyoming, in the Sublette Ridge, Beckwith Hills, and Cokeville areas, the phosphate is comparable in quality and thickness with the Idaho rock, though the thickness of the high-grade bed, containing 70 per cent or more of tricalcium phosphate, is less uniform, apparently ranging from about 3 to 5 feet.
>
> "In the Wind River and Owl Creek mountains there are two phosphate beds, one of which is persistent throughout both ranges, and the other - the lower one - is limited to the southeastern part of the Wind River Range. On the northeastern slope of the Wind River Range, near Lander, along a front of 30 miles the upper bed is 3 to 5 feet thick and contains 40 per cent or more of tricalcium phosphate; elsewhere it is of only slight prospective value. In the same locality the lower bed across several townships is 2 to 4 feet thick and the content of tricalcium phosphate is 45 per cent or more.
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> "The quantity of phosphate rock in the Wyoming fields is very great, though much of it is of medium or low grade. The Sublette Ridge, Beckwith Hills, and Cokeville areas are estimated to contain 37,200,000 tons of high-grade phosphate rock. It is not yet practicable to make estimates of the other fields. Rock has been shipped from Cokeville and Sage, Lincoln County."

The production of phosphate rock for 1919 was 2 cars from Cokeville and 22 cars from Sage, Wyoming.

POTASH.

Potash occurs in the lava rock, Wyomingite, of the Leucite Hills, Sweetwater County. The potash content of the leucite is distributed among the minerals leucite, phlogopite, and a glassy base which is chiefly uncombined silica. Leucite is the chief potash-bearing mineral in Wyomingite. Late Tertiary lava flows

addition, mention should be made of the production of potash and products of Valley Springs Gap, Independence, Kansas. In 1912 4,302 gallons of mineral water were sold from springs, valued at $3,414.00.

IRON ORES.

Workable deposits are found in Lincoln, Uintah counties, and Fremont County, and cover an area which approximately 1,000 square miles of territory. The government has reserved 640, 320 acres of land in Lincoln in western Wyoming, contiguous to Idaho and in the Wind River and Big Horn Mountains are not classified as 1,280,000 acres in the Shoshone Indian Reservation, making a total of 1,920,000 acres. This land is open to development under the act of February 25th, 1909. The principal beds occur principally in the Lower or Park City formation of Carboniferous age. They range from a few feet to 11 feet in thickness. The following is quoted from Mineral Resources, 1914, published by the United States Geological Survey:

"The richest deposit reported in northwestern Wyoming is in the canyon of Dunoir River, 3 miles below the mouth of Tail River. Here, besides the main bed, 9 feet thick, a random sample from which yielded 66.3 per cent of tricalcium phosphate, there are several beds from 2 to 12 feet thick, carrying from 20 to 60 per cent of tricalcium phosphate. In southwestern Wyoming, in the Sublette Ridge, Beckwith Hills, and Cokeville areas, the phosphate is correlated in part with the Leigh rock, though the thickness of the high-grade bed, containing 70 per cent or more of tricalcium phosphate, is less uniform, averaging from about 2 to 3 feet.

"In the Wind River and Owl Creek mountains there are two phosphate beds, one of which is persistent throughout the region, the other - the lower one - is limited to the southeastern part of the Wind River Range. On the northeastern slope of the Wind River Range, near Lander, along a front of 30 miles the upper bed is 3 to 5 feet thick and contains 40 per cent or more of tricalcium phosphate, although it is at only slight prospective value. In the same locality the lower bed across several measures is 2 to 4 feet thick and the content of tricalcium phosphate is 45 per cent or more.

"The quantity of phosphate rock in the Wyoming fields is very great, though much of it is of medium or low grade. The Sublette Ridge, Beckwith Hills, and Cokeville areas are estimated to contain 37,500,000 tons of high-grade phosphate rock. It is not yet practicable to make estimates of the other fields. Rock has been shipped from Cokeville and Kemmerer, Lincoln County."

The production of phosphate rock for 1913 was 5 cars from Cokeville and 22 cars from Sage, Wyoming.

POTASH.

Potash occurs in the lava rock, Wyomingite, of the Leucite Hills, Sweetwater County. The potash content of the Leucite is extracted under the minerals leucite, phlogopite, and a glassy base which is chiefly unconfined silica. Leucite is the other potash-bearing mineral in Wyomingite. Late Tertiary lava flows

probably covered large areas north and northeast of Rock Springs, but the deposits remaining which have resisted erosion are found mostly as the cap rocks of the higher hills and buttes scattered throughout this area. The most important deposits are Pilot Butte, Zirkel Mesa, Emmons Mesa, Cross Mesa, Orenda Mesa, Hague Hill, Endlich Mesa, and Steamboat Mountain.

The United States Geological Survey estimates that Wyomingite contains an average of 10% potash (K_2O) and also 10% alumina (Al_2O_3) and that the aggregate tonnage of potash-bearing rocks in this area is 1,973,496,177 tons, containing 197,349,617 tons of combined potash and a like amount of combined alumina.

An attempt has been made to extract the potash from Wyomingite on a commercial basis, but so far results are not encouraging. The ore from the mine near Superior was transported by aerial tramway to Superior and thence by railroad to Green River, Wyoming, where the reduction plant was located. It appears that the market prices for potash prevailing subsequent to the war were too low to justify continued operations in this plant.

Potash is also found in solution in a small lake near Gillette, Wyoming. The origin is probably the clinker, or burned shale, beds which surround the lake. The clinker beds are the result of burning coal seams and contain potash, soda, and magnesia, which are soluble salts and are leached out by the surface waters draining into the lake. A reduction plant has been located at this site, but no commercial production has been reported.

SALT (HALITE).

Common salt is found in the soda lakes of Albany, Carbon, and Natrona counties and in Salt Creek, Crook County. Salt springs occur in the Star Valley, Lincoln County, and in the early days large amounts of salt were boiled from these springs and were hauled to the mining camps of Idaho and Montana. Another salt producing area is south of Star Valley on Salt Creek. The springs are reported to be in Section 26, T. 29 N., R. 119 W. Only a small production for local use is reported from these localities.

SODA
Sodium Sulphate (Glauber Salts).

Natural soda, or white alkali, consists chiefly of sodium sulphate and is found in a great number of small lakes and basins throughout central, southern, and southwestern Wyoming, more particularly in Carbon, Albany, Natrona, Fremont, Johnson, and Sweetwater counties. Natural soda has been produced commercially from the Union Pacific lakes 13 miles south of Laramie, from the Downey lakes 22 miles southwest of Laramie, from the Rock Creek group 18 miles north of Rock River, and also from deposits in Sweetwater Valley, Natrona County. Sodium sulphate is now being produced on a large scale from lakes 10 miles northeast and 35 miles west of Casper. The production from this source for 1919 was 3,245 tons. The sulphates and carbonates of soda are also produced as a by-product in the Epsom Salts works near Douglas. Wyoming soda deposits are described in United States Geological Survey Bulletin 430, pp. 570 to 590.

Sodium sulphate is one of the State's best mineral resources and there seems to be a great demand for it and its manufactured

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products, which are caustic soda, salt cake, and soda ash. However, the principal market for raw sodium sulphate is in the manufacture of livestock food and the production noted above is for this purpose. The present high freight rates on raw soda from Wyoming points to Kansas City and Chicago are retarding the development of our natural deposits, for the reason that it is difficult to compete with by-product soda (salt cake) manufactured in Chicago and other cities of the middle west. Raw soda is worth about $20.00 per ton in the Chicago market.

Sodium carbonate, or sal soda, is found in many of the alkali deposits associated with sodium sulphate and magnesium sulphate. The percentage of sal soda, however, is generally small. For a number of years sal soda has been produced from wells near Green River, Wyoming. This production at the present time is small.

SULPHUR.

Native sulphur is found in considerable quantities near Thermopolis, Hot Springs County, and near Cody in Park County. Both deposits have been mined to some extent and the product shipped. The sulphur occurs both in massive, practically pure form and in crystalline form disseminated in travertine. Sulphur and travertine were deposited by hot, circulating waters in the crevices and channels of dolomitic limestone. The deposits, therefore, are not solid and continuous but are in pockets and stringers and lenses, and the low-grade disseminated material is far in excess of the pure, massive sulphur. Much of the high grade sulphur has been shipped from these deposits. Plans are now being executed to mine the low-grade sulphur for the manufacture of fertilizer. It is proposed to grind the material up with rock phosphate, which is available near Thermopolis, and to add a bacteria which will render the sulphur content soluble. Other deposits of sulphur in these two counties and also in Fremont County have been reported. The hot springs district in Yellowstone Park also contains important sulphur deposits.

CONCLUSION.

The above description includes practically all the minerals for which an economic future can now be seen with certainty. A number of other minerals, some of which are rare, have been reported from different parts of the State and many of them may prove to be commercially valuable in the future. They are listed as follows, together with the general locality of occurrence:

Agates and crystals:	Natrona, Albany, Crook, Sweetwater, Carbon, Goshen, Platte, Fremont, and Laramie counties.
Alum (aluminum sulphate:	Big Horn, Fremont, Sweetwater, and Crook counties.
Arsenic:	Black Hills
Barite:	Sweetwater County.
Bismuth:	Albany County.
Borax:	Fremont County.
Corundum:	Wind River Mountains.
Diatomaceous Earth:	Sweetwater and Crook counties.
Molybdenite:	Laramie, Big Horn, and Johnson counties.
Nickel:	Converse and Laramie counties.
Tungsten:	Albany County.
Pumice stone:	Albany County.

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CONCLUSION.

The above description includes practically all the minerals [illegible] which an economic future can not be seen with certainty. A number of other minerals, some of which are rare, have been reported from different parts of the State and many of them may prove to be commercially valuable in the future. They are listed as follows, together with the general locality of occurrence:

Agates and crystals:	Laramie, Albany, Crook, Sweetwater, Carbon, Converse, Platte, Fremont, and Laramie counties.
Alum (aluminum sulphate):	Big Horn, Fremont, Sweetwater, and Crook counties.
Arsenic:	Black Hills
Barite:	Sweetwater County.
Bismuth:	Albany County.
Boron:	Fremont County.
Chromite:	Wind River Mountains.
Diatomaceous earth:	Sweetwater and Crook counties.
Glycyrrhizin:	Laramie, Big Horn, and Johnson counties.
Kaolin:	Converse and Laramie counties.
Tungsten:	Albany County.
Zinc blende:	Albany County.